I Volcanism Releases Magma

Topic 1 Magma

OBJECTIVES

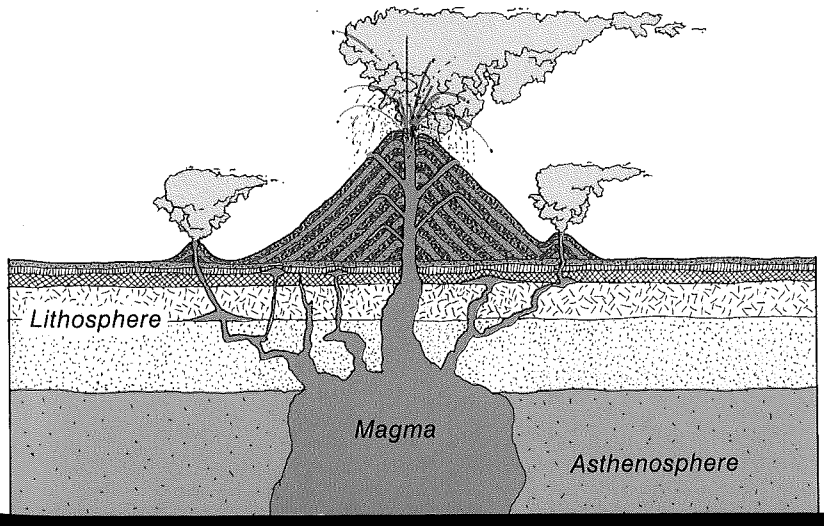
- **A** Identify some areas where rock underground can be melted.
- **B** Explain the difference between magma and lava and describe the composition, properties, and behavior of mafic and felsic magmas and lavas.
- **C** Name some gases that can occur in magma and discuss the relationship between the amount of gas and the nature of the eruption.
- **D** Define *tephra* and give several examples.

The eruption of molten rock must surely be one of the most spectacular activities that accompanies the movement of lithospheric plates. Where does this molten rock come from and how does it move inside Earth? The answers are not simple because the processes occur deep underground where direct observation is not possible. Even so, several facts are known.

Molten rock underground is called **magma.** It forms wherever temperatures and pressures are high enough to melt rock. One region that meets this requirement is the asthenosphere (Chapter 13, Topic 3). At the asthenosphere, some minerals melt and become magma. Plate boundaries are also areas where rocks can be melted. The movements and stresses there produce enough heat to form magma.

Once the rock is melted, it has greater volume and thus is slightly less dense than the unmelted rock around it. The magma then moves upward, moving through fractures or melting crustal rock as it rises. If the magma reaches the surface, it erupts through an opening called a **volcano.**

The rate at which magma moves is determined primarily by its silica content. Silica is the major ingredient in all magma. Magmas with relatively high silica content are thick, light-colored, and slow moving. These are **felsic** magmas. In contrast, **mafic** magmas have relatively low silica content. They tend to be thinner and darker in color, and they flow more easily.



14.1 Magma rises from the asthenosphere through cracks in the lithosphere.

Topic 2 Gases in Magma

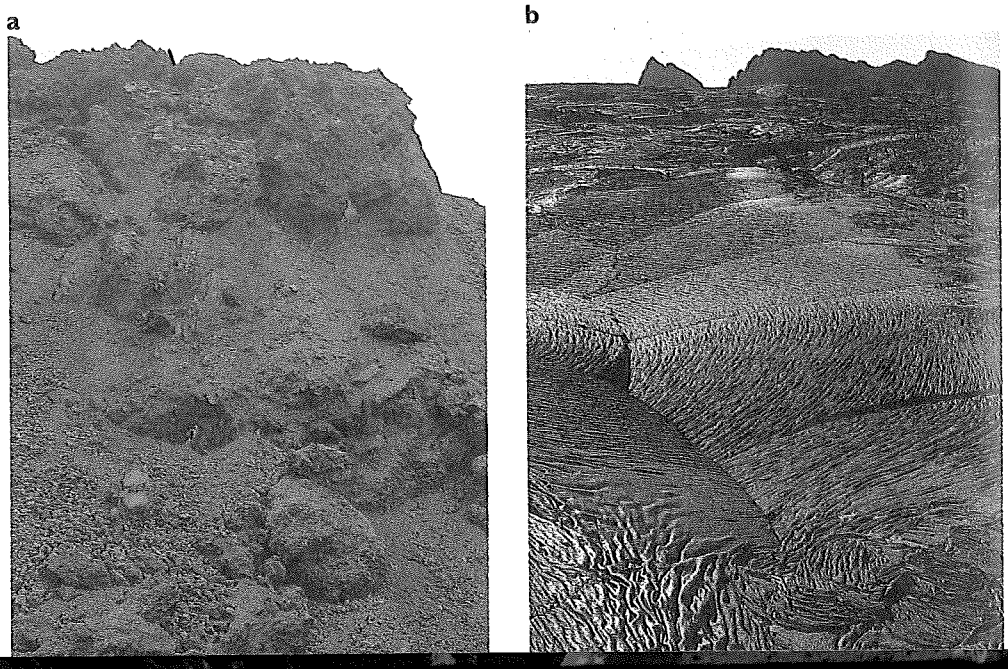
Many magmas contain dissolved gases that are given off as the magma erupts. The most important of these gases are water vapor, carbon dioxide, and sulfur. Other gases include hydrogen, which combines with atmospheric oxygen to form additional steam (hot water vapor). Carbon monoxide combines with oxygen to become carbon dioxide. Sulfur combines with both hydrogen and oxygen and forms the gases hydrogen sulfide and sulfur dioxide. Several other gases, such as chlorine and fluorine, are also given off.

The amount of gas dissolved in a magma is a major factor in the kind of eruption that results. As the magma reaches the surface, the pressure on it is greatly reduced. The gases dissolved in the magma come out of solution as bubbles. These bubbles can expand rapidly and even explode. As a result, magmas containing large amounts of dissolved gases tend to produce more explosive eruptions than magmas containing small amounts of gases.

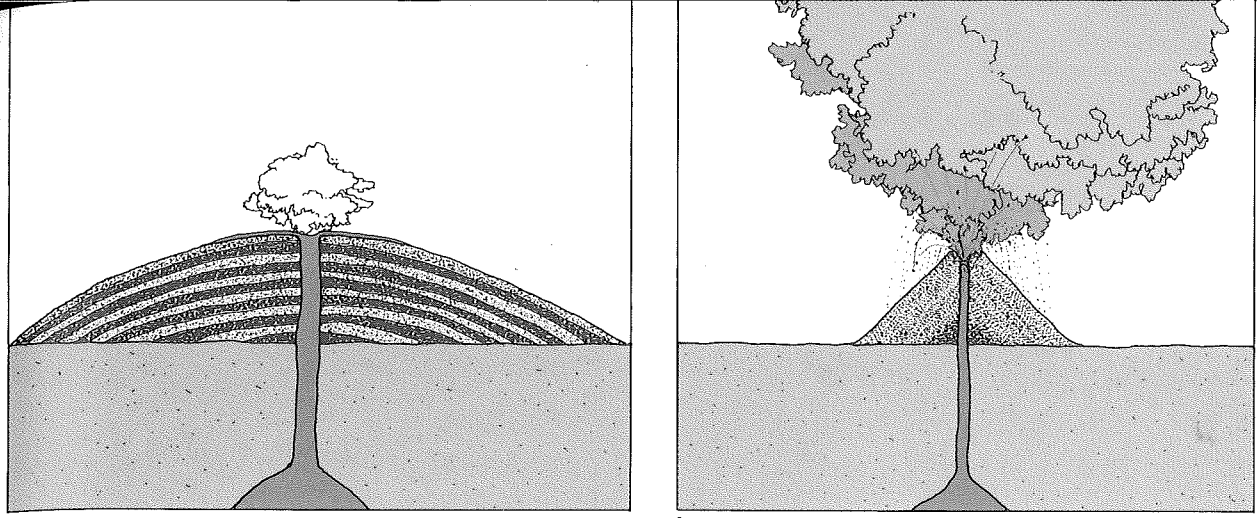
Topic 3 Lava

Magma that reaches the surface is called **lava.** Its composition is somewhat different from that of the original magma because some gases have escaped and some new materials have been added from other rocks the magma has melted. Like magma, lava is classified by its silica content as either felsic or mafic. Like magma, felsic lavas are thick and stiff, while mafic lavas are thin and fluid.

The silica content of the original magma is also important to the type of eruption that occurs. Mafic magmas are more fluid. Thus, gases dissolved within them escape easily. As a result, their lavas pour out smoothly onto the surface. On the other hand, gases cannot move easily in less fluid, felsic magmas. The result is an explosive eruption.



14.2 Since there are different types of lava, lava flows have different appearances. **(a)** Aa lava flows are characterized by rough, jagged surfaces. **(b)** Pahoehoe lava flows are smooth with a ropelike surface.

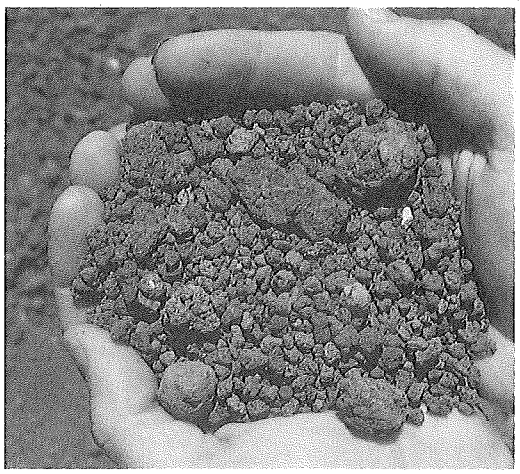


14.3 **(a)** Mafic magma flows out smoothly over a large area. A gently sloping shield cone results. **(b)** Felsic magma is thicker, containing trapped gases. The resulting explosive eruption forms a steep-sided cone called a cinder cone.

Topic 4 Lava Fragments

Explosive eruptions produce solid fragments of lava called **tephra.** The smallest pieces of tephra (less than 2 millimeters in diameter) are called *ash.* Larger pieces (up to 64 millimeters) are called *lapilli.* The largest fragments (more than 64 millimeters) are called *blocks* and *bombs.* Blocks are erupted as solid pieces, while bombs are ejected as liquid and harden as they fall.

In some explosive eruptions, tephra combines with gases to form a dense, superheated cloud that travels downhill with amazing speed. The cloud may follow existing stream valleys and move at more than 100 kilometers per hour. One example of this type of eruption occurred in 1902 when Mount Pelee, a Caribbean volcano, destroyed the city of St. Pierre. The fiery blast shattered stone buildings and burned wooden ones. Within minutes, 30 000 people were smothered or burned to death.



14.4 Volcanic ash and cinders

TOPIC QUESTIONS

Each topic question refers to the topic of the same number.

1. **(a)** What is magma? **(b)** What condition is necessary in order for magma to form? **(c)** List two places where this condition can be met. **(d)** What causes magma to rise? **(e)** What is the major ingredient in magma? **(f)** List the properties of felsic and mafic magmas.
2. **(a)** List several gases that come from magma. **(b)** What effect does the amount of gases in a magma have on the kind of eruption that occurs?
3. **(a)** What is lava? **(b)** Why is the composition of lava different from that of its magma? **(c)** How are felsic lavas different from mafic lavas? **(d)** How are their eruptions different?
4. **(a)** What is tephra? **(b)** How are ash and lapilli different? **(c)** How do blocks form differently than bombs? **(d)** What kind of eruption destroyed St. Pierre?